JDEI Curriculum Development Report

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Overview:

We set out to develop and implement a course-based undergraduate research project into BI211: Principles of Biology as a way to modernize our molecular biology laboratory experiences for our students, while working to increase student retention and improve performance on course and institutional learning outcomes. Research has shown that incorporation of course-based undergraduate research projects is one of the most equitable and effective ways to increase student retention and success in achieving learning outcomes that particularly helps students from historically underrepresented communities in science.

In this work we adapted a commercially available lab kit and designed protocols that allowed students to extract, isolate and test their own DNA for the presence of a common lactose tolerance mutation. Through this project, students gained experience in important laboratory techniques, learning gains related to course outcomes, and personalization of their learning to their own biology.

The FPD award we received was split amongst the three biology faculty which helped to cover our work in summer 2022 to get the lab ready for students in BI211 in fall quarter 2022. Our time was spent:

- Organizing and ordering reagents and materials to run the lab with our setup;
- Troubleshooting protocols to get the experiment to produce reliable results;
- Writing up lab protocols for students;
- Reworking our current curriculum to accommodate the new labs;
- Working with laboratory staff to prep materials to run the lab in our classes;
- Writing formative and summative assessments related to key learning outcomes for the research project.

This new approach to teaching concepts in BI211 that we have designed utilizes three key evidence-based practices that have been shown to improve student learning outcomes equitably across students with different learning strategies and backgrounds: active learning (through hands-on laboratory activities), research (guided inquiry-based learning, problem solving), and the development of a central theme in the course (lactase) to which new concepts can be applied.

Outcomes from the project:

Academic Program Review (APR) identified BI211 as the course in most need of improvement re: student pass rates. While we would need more time to effectively evaluate if this change to curriculum achieved this goal, for fall 2022 we had a 90% pass (C- or better) compared to our APR 5-year average of 70% pass rate. In terms of how well this research project helped to achieve learning outcomes, we compared responses in an anonymous survey pre- and post-project. Learning gains (an improvement of at least 10% in correct responses) were recorded for learning outcomes related to population gene expression patterns, genetics, metabolism, and enzyme function

This project received a Shafer award for Innovation of the Year and was selected to submit to the League for Innovation in the Community College.

Pictures of lab equipment development, set up, and student project results:

Figure 1: Example of reaction conditions to replicate extracted DNA to test for the lactose tolerance mutation. Significant troubleshooting was involved to be able to adapt the commercially available reagents to what we have “in house” so we could run this experiment in our classrooms at lower cost and using equipment we already had.

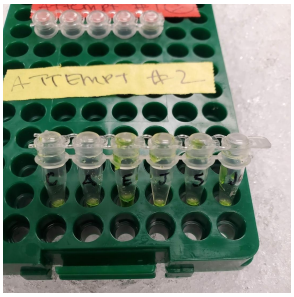
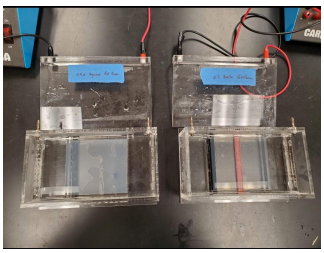


Figure 2: Donated machine and software needed to run the conditions to replicate DNA. Previously this equipment was only available to students doing independent study research, but it is now being used more widely so more students are benefitting from experience working with modern molecular biology equipment.

Figure 3: Gel electrophoresis set up to be able to analyze DNA fragments to determine lactose tolerant mutations. We were able to repurpose the equipment used in forensic chemistry courses for this research project.



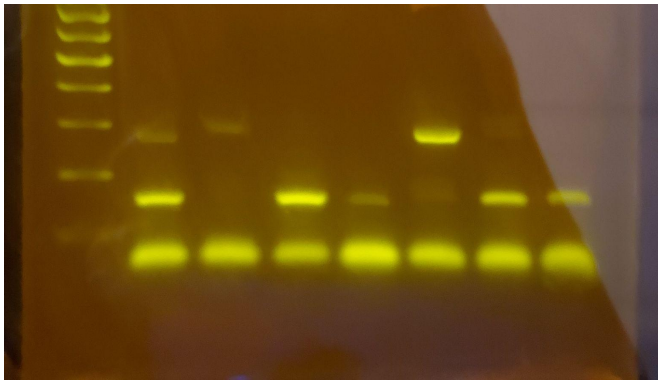


Figure 4: Sample student project results via gel electrophoresis. Each column represents DNA results from a different student; position of bands on the gel indicate different mutations present in their DNA which can be mapped to lactose tolerance or intolerance.